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Origins of the Kuroshio and Mindanao Currents

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LONG-TERM GOALS

The long-term goal of this project is to quantify the processes leading to the bifurcation of the NEC into the northward flowing Kuroshio and the southward Mindanao Current. As these are the dominant currents of the region, the improved dynamical understanding should lead directly to better predictions.

OBJECTIVES

The four objectives are (a) to clarify the dynamic state of the NEC-Kuroshio-Mindanao Current system, (b) to quantify the temporal evolution of the upper ocean temperature and salinity fields, the seasonal mixed layer above the pycnocline, and the deeper mode and intermediate waters, (c) to evaluate the upper ocean heat, salt and potential vorticity budget in the OMKC region, and (d) to improve the predictability of the oceanic circulation variability on various timescales in the OKMC region by incorporating in-situ data, including those from the profiling float measurements.

APPROACH

Profiling floats will be deployed during the duration of the OKMC project. In conjunction, high-quality satellite altimeter sea surface height (SSH) information will be analyzed. By combining the SSH information and profiling float T/S data, we plan to infer the strengths and locations (through dynamic height difference and maximum gradient) of the incoming NEC and the bifurcated Kuroshio and Mindanao Currents. Dynamic height maps from the SSH and float T/S data will be used to put in perspective the temporal and spatial variability of the regional circulation detected by other observational instruments. The broad-scale SSH information will also be used to explore the dynamics for regional variability that is forced remotely in the interior ocean.

WORK COMPLETED

During the 2nd year of the OKMC project(which started in November 2009), we have further our investigation into the temporal changes of the NEC bifurcation and its associated regional circulations with the use of satellite altimeter sea surface height (SSH) data from the past 18 years.

RESULTS

Sea level rise with the trend > 10 mm/yr has been observed in the tropical western Pacific Ocean over the 1993-2009 period. This rate is three times faster than the global mean value of the sea level rise. Analyses of the satellite altimeter data and repeat hydrographic data along 137°E reveal that this regionally enhanced sea level rise is thermosteric in nature and vertically confined to a patch in the upper ocean above the 12°C isotherm. Dynamically, this regional sea level trend is accompanied by southward migration and strengthening of the North Pacific Current (NEC) and North Pacific Countercurrent (NECC). Using a 1.5-layer reduced-gravity model forced by the ECMWF reanalysis wind stress data, the authors find that both the observed sea level rise and the NEC/NECC's southward migrating and strengthening trends are largely attributable to the upper ocean watermass redistribution caused by the surface wind stresses of the recently strengthened atmospheric Walker circulation. Based on the long-term model simulation, it is further found that the observed southward migrating and strengthening trends of the NEC and NECC began in the early 1990s. In the two decades prior to 1993, the NEC and NECC had weakened and migrated northward in response to the decreasing trend in the trade winds across the tropical Pacific Ocean.

IMPACT/APPLICATIONS

It is the first time that the NEC bifurcation, with amplitude exceeding 5 degrees latitude, is captured. This has implications for the forth-coming in-situ observations of the OKMC project, as well as for the ocean processes over the shelf and slope waters off the Philippines and Taiwan that are inherently multi-scaled and pose a challenge to predictability.

RELATED PROJECTS

None

PUBLICATIONS

Qiu, B., and S. Chen, 2010: Interannual-to-decadal variability in the bifurcation of the North Equatorial Current off the Philippines. *J. Phys. Oceanogr.*, **40**, 2525-2538.

Qiu, B., and S. Chen, 2011: Multi-Decadal Sea Level and Gyre Circulation Variability in the Northwestern Tropical Pacific Ocean. *J. Phys. Oceanogr.*, submitted.